NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD
SOUTH DAKOTA SUPPLEMENTS ITALICIZED

IRRIGATION WATER CONVEYANCE HIGH-PRESSURE, UNDERGROUND, PLASTIC PIPELINE

(ft.)
CODE 430DD

DEFINITION

A pipeline and appurtenances installed in an irrigation system.

PURPOSE

To prevent erosion or loss of water quality or damage to the land, to make possible proper management of irrigation water, and to reduce water conveyance losses.

This standard applies to underground thermoplastic pipelines ranging from ½ in. to 27 in. in diameter that are closed to the atmosphere and that are subject to internal pressures of 80 lb./in.^{2} or greater.

The standard includes the design criteria and minimum installation requirements for high-pressure, plastic irrigation pipelines and specifications for the thermoplastic pipe.

CONDITIONS WHERE PRACTICE APPLIES

All pipelines shall be planned and located to serve as an integral part of an irrigation water distribution or conveyance system designed to facilitate the conservation use and management of the soil and water resources on a farm or group of farms.

Water supplies, water quality, and rates of irrigation delivery for the area served by the pipelines shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application method to be used.

Plastic pipelines installed according to this standard shall be placed only in suitable soils where the bedding and backfill requirements can be fully met.

CONSIDERATIONS

Water Quantity

1. Effects on components of the water budget, especially infiltration and evaporation.
2. Effects on downstream flows or aquifers that would affect other water uses or users.
3. Potential use for irrigation water management.
4. Effects of installing a pipeline on vegetation that may have been located next to the original conveyance.

Water Quality

1. Effects of installing the pipeline, replacing other types of conveyances, on channel erosion or the movement of sediment and soluble and sediment-attached substances carried by water.
2. Effects on the movement of dissolved substances into the soils and on percolation below the root zone or to ground water recharge.
3. Effects of controlled water delivery on the temperatures of water resources that could cause undesirable effects on aquatic and wildlife communities.
4. Effects on wetlands or water-related wildlife habitats.
5. Effects on the visual quality of water resources.

Laws and Regulations

This practice must conform to all federal, state, and local laws and regulations. Laws and regulations of particular concern include those involving water rights, land use, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species.

CRITERIA

Working pressure and flow velocity. The minimum acceptable class of pipe shall be that having a *working* pressure rating for water of 80 lb./in.^{2}.

The pipeline shall be designed to meet all service requirements without an operating pressure, including hydraulic transients, or static pressure at any point greater than the pressure rating of the pipe used at that point. As a safety factor against surge or water hammer, the working pressure should not exceed 72 percent of the pressure rating of the pipe, nor should the design flow velocity at system capacity exceed 5 ft./s. If either of these limits is exceeded, special consideration must be given to the flow conditions and measures taken to adequately protect the pipeline against surge.

Capacity. The design capacity of the pipeline shall be based on whichever of the following criteria is greater:

1. The capacity shall be sufficient to deliver the volume of water required to meet the peak-period consumptive use of the crop or crops to be irrigated.
2. The capacity shall be sufficient to provide an adequate stream for all methods of irrigation planned.

Friction losses. For design purposes, friction head losses shall be no less than those computed by the Hazen-Williams equation, using a roughness coefficient, c, equal to 150, *or Manning equation using a "n" valve of 0.009.*

PRESSURE RATING FACTORS FOR PVC AND PE PIPE FOR TEMPERATURE

	Temperature ^0F	*PVC Factor*	*PE Factor*
Up to	*73.4*	*1.00*	*1.00*
	80	*.88*	*.92*
	90	*.75*	*.81*
	100	*.62*	*.70*
	110	*.50*	
	120	*.40*	
	130	*.30*	
	140	*.22*	

To obtain the pipe's reduced pressure rating due to water or other temperatures above 73.4 ^0F, multiply normal pressure rating by the appropriate factor from table.

Outlets. Appurtenances required to deliver water from the pipeline to an individual sprinkler or to a lateral line of sprinklers or surface pipe located on the ground surface shall be known as outlets. Outlets shall have adequate capacity to deliver the design flow to the individual sprinkler, surface lateral line of sprinklers, or surface pipe at the design operating pressure.

Check valves. A check valve shall be installed between the pump discharge and the pipeline where backflow may occur. *Backflow must consider contamination of the water supply as well as damage to the system.*

Pressure-relief valves. A pressure-relief valve shall be installed between the pump discharge and the pipeline if excessive pressure can build up when all valves are closed. Pressure-relief valves shall be installed on the discharge side of the check valve where a reversal of flow may occur and at the end of the pipeline if needed to relieve surge at the end of the line.

Pressure-relief valves shall be no smaller than ¼-in. nominal size for each inch of the pipeline diameter and shall be set to open at a pressure no greater than five lb./in.^{2} above the pressure rating of the pipe.

The pressure at which the valves start to open shall be marked on each pressure-relief valve. Adjustable pressure-relief valves shall be sealed or otherwise altered to prevent changing the adjustment from that marked on the valve.

Manufacturers of pressure-relief valves marketed for use under this standard shall provide capacity tables, based on performance tests, that give the discharge capacities of the valves at the maximum

permissible pressure and differential pressure settings. Such tables shall be the basis for design of pressure setting and of acceptance of these valves.

Air-release valves. The three basic types of air-release valves for use on irrigation pipelines are described below:

An air-release valve, a continuously acting valve that has a small venting orifice, generally ranging between 1/16 and 3/8 in. in size. This valve releases pockets of air from the pipeline once the line is filled and under working pressure.

An air-and-vacuum valve, which has a large venting orifice, exhausts large quantities of air from the pipeline during filling and allows air to reenter the line and prevents a vacuum from forming during emptying. This type of valve is sometimes called air-vacuum-release valve or air-vent-and-vacuum-relief valve. It is not continuous acting because it does not allow further escape of air at working pressure once the valve closes.

A combination air valve is sometimes called a combination air-release and air-vacuum valve or combination air-and-vacuum-relief valve. It is continuous acting and combines the functions of both the air-release valve and the air-and-vacuum valve. Both valves are housed in one valve body.

If needed to provide positive means for air escape during filling and air entry while emptying, air-and-vacuum valves or combination air valves shall be installed at all summits, at the entrance, and at the end(s) of the pipeline. Such valves generally are needed at these locations if the line is truly closed to the atmosphere. However, they may not be needed if other features of the pipe system, such as permanently located sprinkler nozzles or other unclosed service outlets, adequately vent the particular location during filling and emptying operations.

The ratio of air-release valve diameter to pipe diameter for valves intended to release air when filling the pipe should not be less than 0.1. However, small-diameter valves may be used to limit water hammer pressures by controlling air release where control of filling velocities is questionable. Equivalent valve outlet diameter of less than 0.1 are permitted for continuously acting air release valves. Adequate vacuum relief must be provided.

Air-release valves or combination air valves shall be used as needed to permit air to escape from the pipeline while the line is at working pressure. Small orifices of these types shall be sized according to the working pressure and venting requirements recommended by the valve manufacturer.

Manufacturers of air vales marketed for use under this standard shall provide dimensional data, which shall be the basis for selection and acceptance of these valves.

Drainage. Provision shall be made for completely draining the pipeline if a hazard is imposed by freezing temperatures, drainage is recommended by the manufacturer of the pipe, or drainage of the line is specified, for the job. If provisions for drainage are required, drainage outlets shall be located at all low places in the line *and air inlets provided at summits to prevent the development of a vacuum.* These outlets may drain into dry wells or to points of lower elevation. If drainage cannot be provided by gravity, provisions shall be made to empty the line by pumping or by other means.

Flushing. If provisions are needed for flushing the line free of sediment or other foreign material, a suitable valve shall be installed at the distal end of the pipeline.

Thrust control. Abrupt changes in pipeline grade, horizontal alignment, or reduction in pipe size, normally require an anchor or thrust blocks to absorb any axial thrust of the pipeline. Thrust control may also be needed at the end of the pipeline and at in-line control valves.

Thrust blocks and anchors must be large enough to withstand the forces tending to move the pipe, including those of momentum and pressure as well as forces due to expansion and contraction.

The pipe manufacturer's recommendations for thrust control shall be followed. In absence of the pipe manufacturer's requirements, the following formula must be used in designing thrust blocks:

$A = ((98HD^2)/B)(\sin(a/2))$

Where:

A=Area of thrust block required in *square fee*t
H=Maximum working pressure in f*ee*t
D=Inside diameter of pipe in f*ee*t
B=Allowable passive pressure of the soil in *pounds per square foot.*
a=Deflection angle of pipe bend *in degrees.*

Area of thrust blocks for dead ends and tees shall be 0.7 times the area of block required for a 90° deflection angle of pipe bend.

If adequate soil tests are not available, the passive soil pressure may be estimated from Table 1.

Table 1. — Allowable soil bearing pressure

Natural soil material	Depth of cover to center of thrust block			
	2 ft	3 ft	4 ft	5 ft
	----------*lb/ft²*----------			

Sound bedrock .	8,000	10,000	10,000	10,000
Dense sand and gravel mixture (assumed Ø = 40°)	1,200	1,800	2,400	3,000
Dense fine to coarse sand (assumed Ø = 35°)	800	1,200	1,650	2,100
Silt and clay mixture (assumed Ø = 25°)	500	700	950	1,200
Soft clay and organic soils (assumed Ø = 10°)	200	300	400	500

Thrust blocks shall be constructed of concrete and shall have a minimum thickness of six inches and a minimum height equal to the outside diameter of the pipe. The blocks shall fill the space between the pipe and the undisturbed earth at the side of the trench at bends and tees. Blocks at ends of lines shall bear against undisturbed earth or earth compacted at least to the density of the surrounding natural material. Thrust blocks shall be allowed to cure for a seven-day period prior to pressure testing the pipeline.

Materials. All materials shall meet or exceed the minimum requirements indicated in "*Plans and* Specifications."

Minimum Depth of Cover. *The pipeline shall be installed at sufficient depth below the ground surface to provide protection from hazards imposed by traffic crossing, farming operations, freezing temperatures, or soil cracking. The minimum depth of cover shall be:*

1. *18 inches for pipes ½ to 21/2 inches in diameter.*
2. *24 inches for pipes over 21/1 and up to 4 inches in diameter.*
3. *30 inches for pipes over 4 inches in diameter.*

At low places on the ground surface, extra fill may be placed over the pipeline to provide the minimum depth cover. In such cases, the top width of the fill shall be no less than 10 feet and the side slopes no steeper than 6 horizontal to 1 vertical. Where needed, extra protection may be provided at vehicle crossings with encasement pipe or other approved methods.

Trench Construction*. Trench width at any point below top of pipe should be only wide enough to permit the pipe to be easily placed and joined and to allow the initial backfill material to be uniformly placed under the haunches and along the sides of the pipe. The maximum trench width shall be 36 inches. Where the trench is precision excavated with a semi-circular bottom that closely fits the pipe, the width shall not exceed the outside diameter of the pipe by more than 10 percent.*

The trench bottom shall be uniform so that the pipe will lie on the bottom without bridging. Clods, rocks, and uneven spots which could damage or cause nonuniform support to the pipe shall be removed.

If rocks, boulders, or any other material which might damage the pipe are encountered, the trench bottom shall be undercut a minimum of four inches below final grade and filled with bedding material consisting of sands or compacted fine-grained soils.

Provisions shall be made to insure safe working conditions where unstable soil, trench depth, or other conditions are such as to impose safety hazards to personnel working in the trench.

Placement. *Pipe shall be placed in the trench and allowed to come to within a few degrees of the temperature that it will have after complete covering prior to any backfill beyond shading and prior to connecting to other facilities. Care shall be taken to prevent permanent distortion and pipe damage when handling during unusually warm or cold weather. The pipe shall be uniformly and continuously supported over its entire length on firm stable material. Blocking or mounding shall not be used to bring the pipe to final grade.*

For pipe with belled ends, bell holes shall be excavated in the bedding materials as needed to allow for unobstructed assembly of the joint and to permit the body of the pipe to be in contact with the bedding material throughout its length.

Joints and Connections*. All joints and connections shall be made so as to withstand the design maximum working pressure for the pipeline without leakage and shall leave the inside of the line free of any obstruction that may tend to reduce its capacity below design requirements.*

All fittings, such as couplings, reducers, bends, tees, and crosses, shall be installed in accordance with the recommendations of the pipe manufacturer.

Fittings made of steel or other metals subject to corrosion shall be adequately protected by wrapping with plastic tape or coating with high corrosion-preventative qualities. Where plastic tape is used for corrosion protection, all surfaces to be wrapped shall be thoroughly cleaned and then coated with a primer compatible with the tape prior to wrapping.

Testing. *The pipeline shall be tested for pressure strength, leakage, and proper functioning. The tests may be performed prior to complete backfilling (Alternate #1) or anytime after the pipeline is ready for service (Alternate #2).*

Alternate No. 1. *Tests for pressure strength and leaks may be accomplished by inspecting the pipeline and appurtenances while the maximum working pressure is maintained and all joints and connections are uncovered. Partial backfills needed to hold pipe in place during testing shall be placed as specified under Initial Backfill. Any leaks shall be repaired and the system retested.*

Alternate No. 2. *Tests for pressure strength and leakage shall be accomplished after partial or complete backfilling. The pipe shall be filled with water and pressure tested at the working pressure for two hours. The allowable leakage shall not be greater than one gallon per diameter inch per mile. Should the test exceed this rate, the defect shall be repaired until retests show the leakage is within the allowable limits, except that all visible leaks shall be repaired.*

It shall be demonstrated by testing that the pipeline will function properly at design capacity. At or below design capacity there shall be no objectionable flow conditions. Objectionable flow conditions shall include water hammer, continuing unsteady delivery of water, damage to the pipeline, or detrimental discharge from control valves.

Initial Backfill. *Either the hand, mechanical, or water packing methods are optional.*

The initial backfill material shall be selected soil and sand free from rocks or stones large than one inch in diameter. The material shall be so placed that the pipe will not be displaced, excessively deformed, or damaged.

When hand or mechanically backfilling, the initial fill shall be compacted firmly around and above the pipe as required to provide adequate lateral support to the pipe.

When water packing is used, the pipeline first shall be filled with water. The initial backfill before wetting shall be of sufficient depth to insure complete coverage of the pipe after consolidation has taken place. Water packing is accomplished by adding water to diked reaches of the trench in such quantity as to thoroughly saturate the initial backfill without excessive pooling of water. After saturation, the pipeline shall remain full until after final backfill is made. The wetted fill shall be allowed to dry until firm before final backfill is begun.

Final Backfill. *Final backfill material shall be free of large rocks, frozen clods, and other debris greater than three inches in diameter. The material shall be placed and spread in approximately uniform layers in such a manner that there will be no unfilled spaces in the backfill and the backfill will be level with the natural ground or at the design grade required to provide the minimum depth of cover after settlement has taken place. Rolling equipment shall not be used to consolidate the final backfill until the specified minimum depth or cover has been placed.*

All special backfilling requirements of the pipe manufacturer shall be met.

Water Bars. *Small diversion dikes (water bars) should be installed across the backfill on long slopes or other locations where concentrations of runoff water may cause erosion.*

Basis of Acceptance. *The acceptability of the pipeline shall be determined by inspections to check compliance with all the provisions of the standard with respect to the pipe and pipe marking, the appurtenances used, and the minimum installation requirements.*

Certification and Guarantee. *If requested by the state conservation engineer, a qualified testing laboratory must certify with supporting these results that the pipe meets the requirements specified in this standard. The seal of approval of a recognized laboratory on pipe bearing one of the ASTM designations listed in this standard may be accepted for this certification.*

The installing contractor shall certify that his installation complies with the requirements of this standard. He shall furnish a written guarantee which protects the owner against defective workmanship and materials for a period of not less than one year. The certification identifies the manufacturer and markings of the pipe used.

TABLE 2
PVC AND ABS PLASTIC IRRIGATION PIPE (PIP)
Non-threaded

Nominal Pipe Size (in.)	SDR	PVC Pressure Ratings (lb./in.2)				Dimensions and Tolerance					ABS Pressure Ratings (lb./in.2)		
		Material				Wall Thickness		Outside Diameter	+ Tolerance		Material		
		1120 1220	2116	2112	2110	Min. (in.)	Tolerance (in.)	Average (in.)	Av. O.D. (in.)	Max. & Min. (in.)	1316	2112	1210
4	51	80				0.081	+0.020	4.130	0.009	0.050			
	41	100	80			.101	+.020				80		
	32.5	125	100	80		.127	+.020				100	80	
	26	160	125	100	80	.159	+.020				125	100	80
6	51	80				.120	+.020	6.140	.011	.050			
	41	100	80			.150	+.020				80		
	32.5	125	100	80		.189	+.023				100	80	
	26	160	125	100	80	.236	+.028				125	100	80
8	51	80				.160	+.020	8.160	.015	.070			
	41	100	80			.199	+.024				80		
	32.5	125	100	80		.251	+.031				100	80	
	26	160	125	100	80	.314	+.038				125	100	80
10	51	80				.200	+.024	10.200	.015	.075			
	41	100	80			.249	+.030				80		
	32.5	125	100	80		.314	+.038				100	80	
	26	160	125	100	80	.392	+.047				125	100	80
12	51	80				.240	+.029	12.240	.015	.075			
	41	100	80			.299	+.036				80		
	32.5	125	100	80		.377	+.045				100	80	
	26	160	125	100	80	.471	+.056				125	100	80
14	51	80				.280	+.034	14.280	.015	.075			
	41	100	80			.348	+.042				80		
	32.5	125	100	80		.439	+.053				100	80	
	26	160	125	100	80	.549	+.066				125	100	80
15	51	80				.300	+.036	15.300	.015	.075			
	41	100	80			.373	+.045				80		
	32.5	125	100	80		.471	+.057				100	80	
	26	160	125	100	80	.588	+.071				125	100	80
16	51	80				.314	+.38	16.314	.015	.075			
	41	100	80			.390	+.47				80		
	32.5	125	100	80		.492	+.59				100	80	
	26	160	125	100	80	.615	+.74				125	100	80
18	51	80				.367	+.44	18.367	.015	.075			
	41	100	80			.456	+.127				80		
	32.5	125	100	80		.575	+.69				100	80	

TABLE 3
PVC AND ABS THERMOPLASTIC PIPE (SDR-PR) – (IPS)
Non-threaded

Nominal Pipe Size (in.)	SDR	PVC Pressure Ratings (lb./in.2)				Dimensions and Tolerance					ABS Pressure Ratings (lb./in.2)			
		Material				Wall Thickness		Outside Diameter			Material			
									+ Tolerance					
		1120 1220	2116	2112	2110	Min. (in.)	Tolerance (in.)	Average (in.)	Av. O.D. (in.)	Max. & Min. (in.)	1316	2112	1210	1208
5	41	100	80			.136	+.020	5.63	.010	.050				
	32.5	125	100	80		.171	+.021			.050				
	26	160	125	100	80	.214	+.027			.050	125	100	80	
	21	200	160	125	100	.265	+.032			.050	160	125	100	80
	17	250	200	160	125	.327	+.039			.030	200	160	125	100
	13.5	315	250	200	160	.412	+.049			.030	250	200	160	125
6	41	100	80			.162	+.020	6.625	.011	.050				
	32.5	125	100	80		.204	+.024			.050				
	26	160	125	100	80	.255	+.031			.050	125	100	80	
	21	200	160	125	100	.316	+.038			.050	160	125	100	80
	17	250	200	160	125	.390	+.047			.035	200	160	125	100
	13.5	315	250	200	160	.491	+.059			.035	250	200	160	125
8	41	100	80			.210	+.025	8.625	.015	.075				
	32.5	125	100	80		.265	+.032			.075				
	26	160	125	100	80	.332	+.040			.075	125	100	80	
	21	200	160	125	100	.410	+.049			.075	160	125	100	80
	17	250	200	160	125	.508	+.061			.045				
10	41	100	80			.262	+.031	10.750	.015	.075				
	32.5	125	100	80		.331	+.040			.075				
	26	160	125	100	80	.413	+.050			.075	125	100	80	
	21	200	160	125	100	.511	+.061			.075	160	125	100	80
	17	250	200	160	125	.632	+.076			.050				
12	41	80				.311	+.037	12.750	.015	.075				
	32.5	125	100	80		.392	+.047			.075				
	26	160	125	100	80	.471	+.056			.075	125	100	80	63
	21	200	160	125	100	.606	+.073			.075	160	125	100	80
	17	250	200	160	125	.750	+.090			.060				
16	41	100	80			.389	+0.47	16	.024	.075				
	32.5	125	100	80		.492	+0.59			.075				
	26	160	125	100	80	.615	+0.74			.075	125	100	80	

PLANS AND SPECIFICATIONS

Plans and specifications for constructing high-pressure underground plastic pipeline shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purposes.

OPERATION AND MAINTENANCE

A plan of operation and maintenance shall be prepared for use by the owner or others responsible for the system to insure that each component functions properly.